A Simulation of Traffic Crashes into the 21st Century

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by

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Abstract

Major reductions in the number of traffic crashes of various severities in Australia over the past 30 years have led some to think of a Zero Road Toll target as being both desirable and feasible in the near future. However, a number of demographic and travel behaviour changes have been occurring which will cast serious doubt on the feasibility of such a target. These changes reflect the fact that:

- There will be more older people in the population in the future;
- Older people in the future are more likely to have a drivers licence;
- Licenced people travel more and and are less likely to use non-car-driver modes;
- Older people have higher driver crash rates than middle-aged people; and
- Older people have higher crash rates as pedestrians than as drivers .

Taken together, these five factors suggest that the number of crashes involving older people may increase in the future. For this reason, this paper describes the development and application of a simulation model that predicts the number of crashes by various demographic groups in future years. The model shows that, assuming no change in crash rates within demographic groups, the number of fatal and serious injury crashes for young males and females (less than 30 years of age) remains essentially constant over the next 30 years, while middle-aged (30 to 60) males and females will show a 25% increase in the number of fatal and serious injury crashes. The real growth area is for people over 60, where a 175% increase in fatal and serious injury crashes can be expected. Males over 60 will experience a 150% increase in fatal and serious injury crashes, while females over 60 will experience a 200% increase in fatal and serious injury crashes.

The analysis demonstrates that known demographic changes will place severe pressures on the vision of a Zero Road Toll. Substantial reductions in crash rates within demographic groups will be needed to counter the increases in the numbers of people in demographic groups which have a higher crash involvement rate.

Introduction

Major reductions in the number of traffic crashes of various severities in Australia over the past 30 years have led some to think of a Zero Road Toll target as being both desirable and feasible in the near future. However, a number of demographic and travel behaviour changes have been occurring which will cast serious doubt on the feasibility of such a target. These changes reflect the fact that:

- There will be more older people in the population in the future;
- Older people in the future are more likely to have a drivers licence;
- Licenced people travel more and are less likely to use non-car-driver modes;
- Older people have higher driver crash rates than middle-aged people; and
- Older people have higher crash rates as pedestrians than as drivers.

Taken together, these five factors suggest that the number of crashes involving older people may increase substantially in the future. However, the magnitude of this change is unknown at this stage. For this reason, this paper describes the development and application of a simulation model that predicts the number of crashes by various demographic groups in future years.

The model has been developed for Melbourne for the years 1996-2031, although the model could easily be extended by the provision of more input data for other cities and future years. The model is spreadsheet-based and relies on the results from research into several of the points listed above. The model applies to males and females of ages above 20, and considers travel as car driver, car passenger and pedestrian. The structure of the model is similar for all these groups.

As described in a companion paper (Richardson, 2001), the data used for this analysis comes from two major sources. The crash involvement data was obtained from VicRoads in the form of a database entitled "CrashStats". This database contains Road Crash Statistics for the State of Victoria for the years 1991 through to 1999, for crashes where at least one person was injured. Police reports form the basic source of crash data. The data is converted from number of crashes (where there is one data record for each crash, perhaps involving several people) into number of crash involvements (where there is one data record for each of the people involved). The road user exposure data comes from the Victorian Activity and Travel Survey (VATS) conducted by the Transport Research Centre (TRC). The information being used in this analysis from both data sets is from the period January 1994 through December 1995. In addition, data on population projections and demographic composition comes from a variety of sources within the Australian Bureau of Statistics (ABS).

The Structure of the Model

Essentially, the model consists of ten steps, as follows :

- Estimate the age distribution by sex for future years
- Estimate licence holding by age and sex for future years
- Calculate the number of licenced and un-licenced people by age and sex for future years
- Estimate the average number of kilometres travelled by mode for licenced and un-licenced people by age and sex for future years
- Calculate the total number of kilometres travelled by mode for licenced and un-licenced people by age and sex for future years
- Calculate the total number of kilometres travelled by mode by age and sex for future years
- Estimate crash involvement rates by mode for crashes of various severities by age and sex
- Calculate the total number of crashes of various severities by mode by age and sex for future years
- Aggregate the number of crashes of various severities by sex for future years
- Calculate crash rates of various severities per head of population for future years

The steps involved in the crash simulation model will now be illustrated by means of the calculation of future crashes for male car passengers. The same procedure applies to all demographic groups and modes, and the results from these demographic groups and modes will later be combined into an overall result.

Step 1: Estimate the age distribution by sex for future years

The first step in the simulation is to estimate the age distribution by sex for future years. This information has been obtained for Victoria from ABS population projections. The population projections for males in Victoria are shown in Table 1.

Table 1 Victorian Population Projections for Males

Age Group	Victorian Population 1996	2001	2006	2011	2016	2021	2026	2031
20->24	175619	171728	176148	179363	180075	175509	173944	172256
25->29	179113	180748	176101	181136	184065	184865	180318	178674
30->34	178957	182915	184316	179673	185014	187755	188614	184102
35->39	179533	179875	183103	184598	179981	185406	187994	188863
40->44	166489	178692	178871	181898	183445	178870	184332	186815
45->49	158888	165296	177178	177460	180355	181950	177494	182987
50->54	126864	156309	162332	174143	174568	177401	179110	174823
55->59	105099	123740	152675	158789	170518	171112	173992	175836
60->64	90371	100605	119257	147388	153526	165109	165946	168982
65->69	86364	83492	94176	112144	138778	144966	156319	157496
70->74	70224	75684	74405	84634	101308	125791	132013	142979
75+	88690	108458	126917	137981	152988	177768	216574	249235
Total	1606211	1707542	1805479	1899207	1984621	2056502	2116650	2163048

Table 1 refers to Victorian population projections. However, the simulation model only makes estimates of crash involvement at the Melbourne Metropolitan Area level (mainly due to limitations in data sources for other parts of the analysis). Therefore, the above population projections have to be converted to Melbourne projections (these projections were not available by age and sex for the Melbourne area). The conversion from Victorian to Melbourne population projections was done by estimating the proportion of Victorians (by age and sex) who live in Melbourne in 1996 (using the 1996 ABS Census data). The results of this analysis are shown in Figure 1. It can be seen that a higher proportion of 20-30 year olds live in Melbourne, while the proportion living in Melbourne generally falls with increasing age beyond the age of 30.

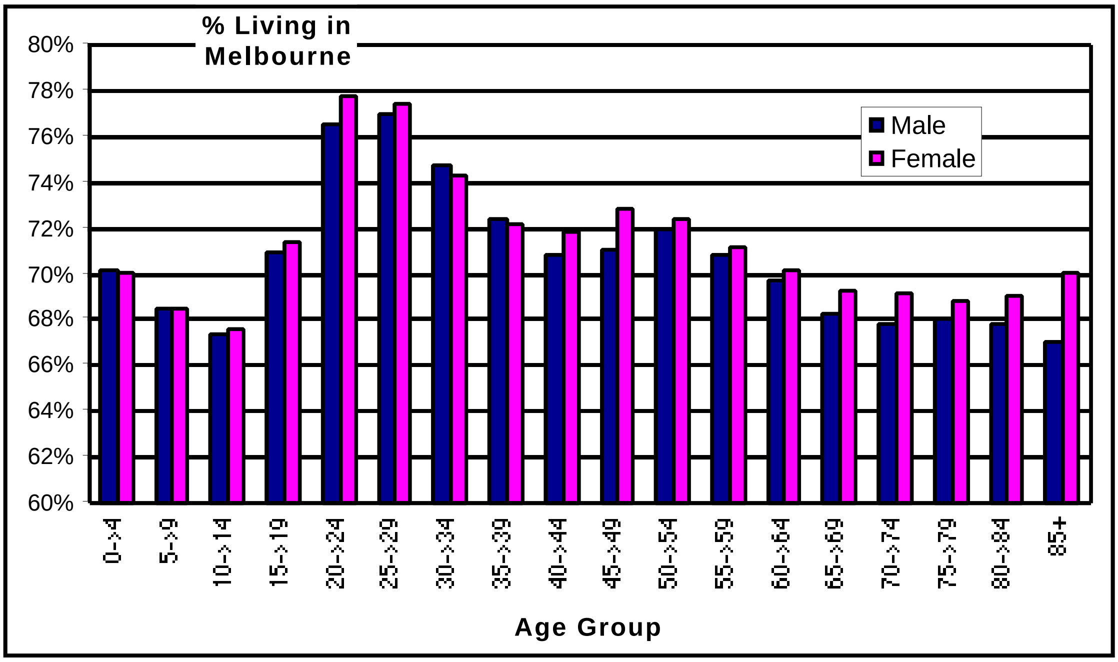

Figure 1 Proportion of Victorians living in Melbourne (ABS Census 1996)

These proportions are assumed to remain relatively constant over time, and were therefore applied to the Victorian population projections to obtain the Melbourne population projections, as shown in Table 2 for males.

Table 2 Melbourne Population Projections for Males

	Melbourne Population							
Age Group	1996	2001	2006	2011	2016	2021	2026	2031
20->24	134456	131477	134861	137322	137867	134372	133173	131881
25->29	137929	139188	135609	139487	141742	142358	138857	137591
30->34	133866	136826	137874	134401	138397	140447	141090	137714
35->39	130051	130299	132637	133720	130375	134305	136180	136809
40->44	117997	126646	126773	128918	130014	126772	130643	132403
45->49	112977	117533	125982	126182	128241	129375	126207	130112
50->54	91280	112466	116800	125298	125604	127642	128872	125787
55->59	74508	87723	108235	112570	120885	121306	123348	124655
60->64	63040	70179	83190	102813	107095	115175	115759	117877
65->69	58928	56969	64259	76519	94692	98914	106660	107464
70->74	47655	51360	50492	57434	68749	85363	89585	97027
75+	60119	73518	86031	93531	103703	120500	146805	168944
Total	1162805	1234184	1302743	1368195	1427364	1476529	1517178	1548265

Step 2: Estimate licence holding by age and sex for future years

The next step is to estimate the proportion of the male population who will hold a driving licence in each of the age groups in future years. Using data from VicRoads licencing branch, a cohort modelling exercise was undertaken to estimate licence holding by age and sex over the coming years. The estimates of male licence holding in Melbourne over the next 30 years are shown in Table 3.

Table 3 Estimated Licence Holding for Males

	% Licenced							
Age Group	1996	2001	2006	2011	2016	2021	2026	2031
20->24	91%	87%	87%	87%	87%	87%	87%	87%
25->29	95%	97%	97%	97%	97%	97%	97%	97%
30->34	99%	100%	100%	100%	100%	100%	100%	100%
35->39	98%	100%	100%	100%	100%	100%	100%	100%
40->44	96%	100%	100%	100%	100%	100%	100%	100%
45->49	97%	99%	100%	100%	100%	100%	100%	100%
50->54	94%	98%	99%	100%	100%	100%	100%	100%
55->59	95%	98%	98%	99%	100%	100%	100%	100%
60->64	92%	97%	98%	98%	99%	100%	100%	100%
65->69	91%	95%	97%	98%	98%	99%	100%	100%
70->74	87%	93%	95%	97%	98%	98%	99%	100%
75+	75%	85%	89%	92%	93%	97%	98%	98%
Total	94%	96%	97%	97%	98%	98%	98%	98%

Step 3: Calculate the number of licenced and un-licenced people by age and sex

Given the population in each age group (Table 2) and the percent holding licences (Table 3), the next step is to calculate the number of licenced and un-licenced people in each age group over the next 30 years.

Step 4: ***Estimate the average number of kilometres travelled by mode for licenced and un-licenced people by age and sex for future years***

The next step is to estimate how far each person travels using the different modes. The average kilometres travelled per year by different modes by licenced and un-licenced males in each age group has been obtained from an analysis of the VATS databases for 1994-95. The average kilometres travelled per year as a car passenger by licenced and un-licenced males are shown in Figure 2. It can be seen, as expected, that un-licenced males travel more as car passenger than licenced males. It is assumed that this level of exposure as a car passenger remains constant into the future within each of the age groups for licenced and un-licenced males (although the number of males in each group may well change in the future).

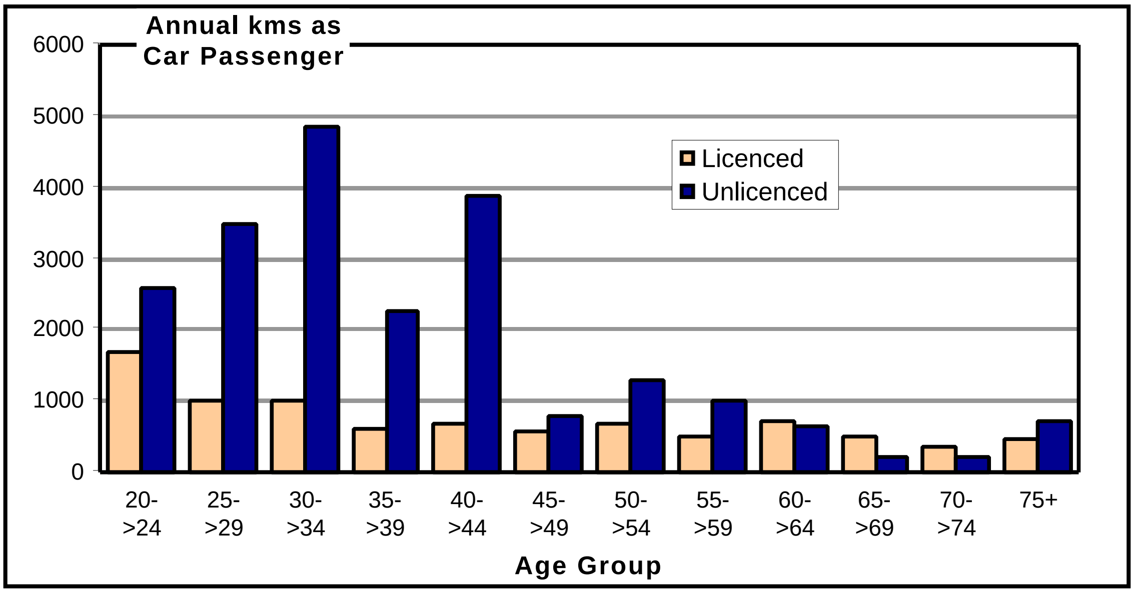

Figure 2 **Annual Kilometres as Car Passenger by Licenced and Un-Licenced Males**

Step 5: ***Calculate the total number of kilometres travelled by mode for licenced and un-licenced people by age and sex for future years***

The total kilometres travelled as a car passenger within each age group by licenced and un-licenced males is estimated by multiplying the number of males in each group (from Step 3) by their average annual kilometres (from Figure 2).

Step 6: ***Calculate the total number of kilometres travelled by mode by age and sex for future years***

The number of kilometres travelled per year as a car passenger by licenced and un-licenced males is now aggregated into a total figure for all males, as shown in Table 4.

Table 4 Total Kilometres Travelled as Passenger by All Males in Melbourne

	Total Kilometres as Passenger (million kms)							
Age Group	1996	2001	2006	2011	2016	2021	2026	2031
20->24	239	239	245	249	250	244	242	239
25->29	156	151	147	151	154	154	150	149
30->34	137	137	137	134	138	140	141	137
35->39	85	80	82	82	80	83	84	84
40->44	95	87	86	88	89	86	89	90
45->49	67	69	74	74	75	76	74	76
50->54	64	77	79	84	84	86	86	84
55->59	38	44	54	55	59	59	60	60
60->64	44	49	59	72	75	81	82	83
65->69	29	28	32	39	48	51	55	55
70->74	16	18	18	20	24	30	32	35
75+	32	38	44	47	52	59	72	82
Total	1004	1016	1057	1097	1128	1149	1166	1177

Step 7: Estimate crash involvement rates by mode for crashes of various severities by age and sex

The crash involvement rates by sex and age group are obtained from an analysis of the CrashStats and VATS data described above. A companion paper (Richardson, 2001) has detailed the calculation of crash involvement rates for car drivers. A similar methodology has also been used to calculate the crash involvement rate (by age, sex and crash severity) for car passengers and pedestrians. The crash involvement rates for male passengers are shown in Table 5.

Table 5 Crash Involvement Rates for Male Passengers in Melbourne

	Crash Rates (per million kilometres)				
Age Group	All Crashes	Fatalities	Serious Injury	Minor Injury	No Injury
20->24	2.916	0.014	0.319	0.824	1.773
25->29	2.401	0.013	0.268	0.641	1.493
30->34	1.582	0.007	0.167	0.542	0.865
35->39	1.865	0.012	0.188	0.641	1.022
40->44	1.421	0.016	0.072	0.416	0.929
45->49	1.379	0.000	0.095	0.448	0.844
50->54	1.435	0.000	0.083	0.469	0.892
55->59	1.675	0.000	0.182	0.469	1.034
60->64	1.139	0.000	0.151	0.364	0.623
65->69	1.703	0.000	0.158	0.769	0.760
70->74	2.008	0.033	0.144	0.827	0.990
75+	1.629	0.033	0.255	0.545	0.781
Total	2.039	0.011	0.203	0.606	1.228

Step 8: Calculate the total number of crash involvements of various severities by mode by age and sex for future years

Using the estimates of total kilometres travelled as car passengers in Table 4 and the crash involvement rates given in Table 5, the estimate of the future number of crash involvements of various severities by each age group is calculated. This is shown in Tables 6 through 10 for the various degrees of severity.

Table 6 Future Estimates of All Crash Involvements by Male Passengers

Age Group	All Crashes Crash Rates	Total Crashes 1996	2001	2006	2011	2016	2021	2026	2031
20->24	2.92	698	695	713	727	729	711	704	698
25->29	2.40	376	362	353	363	369	370	361	358
30->34	1.58	216	216	217	212	218	221	222	217
35->39	1.86	159	150	153	154	150	154	156	157
40->44	1.42	135	124	123	125	126	123	127	128
45->49	1.38	93	96	102	102	104	105	102	105
50->54	1.44	92	110	114	121	121	123	124	121
55->59	1.68	64	73	90	93	98	99	100	101
60->64	1.14	50	56	67	82	86	92	93	95
65->69	1.70	49	48	55	66	82	86	94	94
70->74	2.01	33	36	36	41	49	61	64	70
75+	1.63	53	62	71	76	84	96	117	134
Total	2.04	2018	2028	2093	2161	2216	2241	2265	2278

Table 7 Future Estimates of Fatal Crash Involvements by Male Passengers

Age Group	Fatalities Crash Rates	Total Fatalites 1996	2001	2006	2011	2016	2021	2026	2031
20->24	0.01	3	3	3	4	4	3	3	3
25->29	0.01	2	2	2	2	2	2	2	2
30->34	0.01	1	1	1	1	1	1	1	1
35->39	0.01	1	1	1	1	1	1	1	1
40->44	0.02	2	1	1	1	1	1	1	1
45->49	0.00	0	0	0	0	0	0	0	0
50->54	0.00	0	0	0	0	0	0	0	0
55->59	0.00	0	0	0	0	0	0	0	0
60->64	0.00	0	0	0	0	0	0	0	0
65->69	0.00	0	0	0	0	0	0	0	0
70->74	0.03	1	1	1	1	1	1	1	1
75+	0.03	1	1	1	2	2	2	2	3
Total	0.01	11	11	11	11	11	12	12	13

Table 8 Future Estimates of Serious Injury Crash Involvements by Male Passengers

Age Group	Serious Injury Crash Rates	Total Serious Injuries 1996	2001	2006	2011	2016	2021	2026	2031
20->24	0.32	76	76	78	79	80	78	77	76
25->29	0.27	42	40	39	41	41	41	40	40
30->34	0.17	23	23	23	22	23	23	23	23
35->39	0.19	16	15	15	15	15	16	16	16
40->44	0.07	7	6	6	6	6	6	6	6
45->49	0.10	6	7	7	7	7	7	7	7
50->54	0.08	5	6	7	7	7	7	7	7
55->59	0.18	7	8	10	10	11	11	11	11
60->64	0.15	7	7	9	11	11	12	12	13
65->69	0.16	5	4	5	6	8	8	9	9
70->74	0.14	2	3	3	3	4	4	5	5
75+	0.26	8	10	11	12	13	15	18	21
Total	0.20	204	206	213	220	226	229	232	234

Table 9 Future Estimates of Minor Injury Crash Involvements by Male Passengers

Age Group	Minor Injury Crash Rates	Total Minor Injuries 1996	2001	2006	2011	2016	2021	2026	2031
20->24	0.82	197	197	202	205	206	201	199	197
25->29	0.64	100	97	94	97	98	99	96	95
30->34	0.54	74	74	74	73	75	76	76	74
35->39	0.64	55	51	52	53	51	53	54	54
40->44	0.42	40	36	36	37	37	36	37	38
45->49	0.45	30	31	33	33	34	34	33	34
50->54	0.47	30	36	37	39	39	40	41	40
55->59	0.47	18	20	25	26	28	28	28	28
60->64	0.36	16	18	21	26	27	30	30	30
65->69	0.77	22	22	25	30	37	39	42	43
70->74	0.83	13	15	15	17	20	25	26	29
75+	0.55	18	21	24	26	28	32	39	45
Total	0.61	613	618	639	661	681	692	702	707

Table 10 Future Estimates of "No Injury" Crash Involvements by Male Passengers

Age Group	No Injury Crash Rates	Total No Injuries 1996	2001	2006	2011	2016	2021	2026	2031
20->24	1.77	425	423	434	442	443	432	428	424
25->29	1.49	234	225	219	226	229	230	224	222
30->34	0.87	118	118	119	116	119	121	122	119
35->39	1.02	87	82	84	84	82	85	86	86
40->44	0.93	88	81	80	82	82	80	83	84
45->49	0.84	57	59	63	63	64	64	63	65
50->54	0.89	57	68	71	75	75	76	77	75
55->59	1.03	39	45	55	57	61	61	62	63
60->64	0.62	27	31	36	45	47	51	51	52
65->69	0.76	22	22	25	30	37	38	42	42
70->74	0.99	16	18	18	20	24	30	32	34
75+	0.78	25	30	34	37	40	46	56	64
Total	1.23	1196	1201	1237	1275	1304	1315	1325	1330

Note that this analysis does not allow for variations in crash involvement rates over time, and hence merely shows the pressures on crash involvements due to demographic changes. This restriction will be relaxed later to show what might occur given improvements in crash involvement rate within each demographic group.

Step 9: Aggregate the number of crash involvements of various severities by sex for future years

Steps 1 through 8 are now repeated for each mode of travel (driver, passenger and pedestrian) and for each sex (male, female). The results are then aggregated to provide an overview of the total number of estimated crash involvements of various severities by various modes for males and females. The results are shown in Tables 11 through 13.

Table 11 Future Estimates of Crash Involvements by Males (>20 years old)

Drivers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	11199	11934	12502	13030	13463	13786	14036	14220
Total Fatalites	56	61	66	70	74	78	83	88
Total Serious Injuries	940	1005	1058	1107	1151	1188	1225	1253
Total Minor Injuries	2967	3164	3321	3467	3586	3679	3755	3813
Total No Injuries	7303	7775	8131	8463	8730	8919	9051	9142

Passengers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	2018	2028	2093	2161	2216	2241	2265	2278
Total Fatalites	11	11	11	11	11	12	12	13
Total Serious Injuries	204	206	213	220	226	229	232	234
Total Minor Injuries	613	618	639	661	681	692	702	707
Total No Injuries	1196	1201	1237	1275	1304	1315	1325	1330

Pedestrians	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	588	609	637	668	699	729	759	784
Total Fatalites	32	34	36	39	42	46	49	53
Total Serious Injuries	241	249	260	273	285	296	307	317
Total Minor Injuries	307	317	331	347	362	377	392	403
Total No Injuries	8	8	8	9	9	9	9	9

TOTAL	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	13805	14570	15233	15860	16379	16756	17060	17282
Total Fatalites	98	106	113	120	127	136	145	153
Total Serious Injuries	1385	1459	1531	1599	1663	1713	1764	1804
Total Minor Injuries	3888	4098	4291	4475	4629	4747	4848	4923
Total No Injuries	8508	8984	9377	9747	10042	10243	10384	10481

Table 12 Future Estimates of Crash Involvements by Females (>20 years old)

Drivers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	7180	7848	8385	8862	9271	9619	9926	10186
Total Fatalites	14	16	17	19	20	22	23	25
Total Serious Injuries	794	889	971	1044	1110	1176	1239	1295
Total Minor Injuries	3286	3582	3819	4030	4213	4366	4498	4608
Total No Injuries	3019	3289	3501	3686	3838	3962	4069	4157

Passengers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	3084	3282	3466	3655	3812	3930	4005	4067
Total Fatalites	17	18	19	21	23	25	27	29
Total Serious Injuries	372	396	419	443	463	480	492	503
Total Minor Injuries	1378	1471	1558	1647	1721	1778	1813	1843
Total No Injuries	1278	1353	1423	1495	1552	1592	1616	1634

Pedestrians	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	520	537	559	584	610	636	662	686
Total Fatalites	19	20	21	23	25	27	29	31
Total Serious Injuries	199	209	219	229	240	253	267	280
Total Minor Injuries	293	300	311	324	336	347	357	366
Total No Injuries	8	8	8	8	8	8	8	8

TOTAL	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	10784	11667	12411	13102	13693	14185	14593	14938
Total Fatalites	50	55	58	63	68	75	80	85
Total Serious Injuries	1366	1494	1609	1716	1814	1909	1998	2078
Total Minor Injuries	4958	5352	5688	6001	6271	6491	6668	6817
Total No Injuries	4305	4651	4932	5189	5399	5562	5693	5799

Table 13 Future Estimates of Crash Involvements by All People (>20 years old)

Drivers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	18379	19782	20887	21893	22734	23405	23962	24405
Total Fatalites	71	78	83	89	94	100	107	113
Total Serious Injuries	1734	1894	2029	2151	2261	2363	2464	2548
Total Minor Injuries	6253	6745	7140	7497	7800	8044	8252	8421
Total No Injuries	10322	11064	11632	12150	12568	12882	13120	13299

Passengers	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	5102	5310	5560	5817	6028	6172	6270	6346
Total Fatalites	27	29	30	32	34	37	39	42
Total Serious Injuries	576	602	632	663	689	709	724	737
Total Minor Injuries	1991	2088	2197	2308	2403	2470	2515	2550
Total No Injuries	2474	2554	2660	2770	2856	2906	2940	2964

Pedestrians	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	1108	1146	1196	1252	1309	1364	1421	1469
Total Fatalites	51	54	58	62	67	73	79	84
Total Serious Injuries	440	458	479	502	526	550	574	597
Total Minor Injuries	600	617	643	670	698	723	749	769
Total No Injuries	17	16	16	17	17	17	17	17

TOTAL	1996	2001	2006	2011	2016	2021	2026	2031
Total Crash Involvements	24589	26237	27643	28961	30071	30941	31653	32220
Total Fatalites	149	160	171	183	196	210	225	238
Total Serious Injuries	2751	2953	3140	3316	3476	3622	3762	3882
Total Minor Injuries	8845	9451	9979	10475	10901	11238	11516	11741
Total No Injuries	12813	13634	14309	14937	15441	15805	16077	16280

The overall results from Table 13 can also be presented graphically, as show in Figure 5. It can be seen that because of demographic changes, fatalities and serious injuries would be expected to rise for all modes of travel for males and females over the next 30 years (if the crash involvement rate does not change within each demographic group).

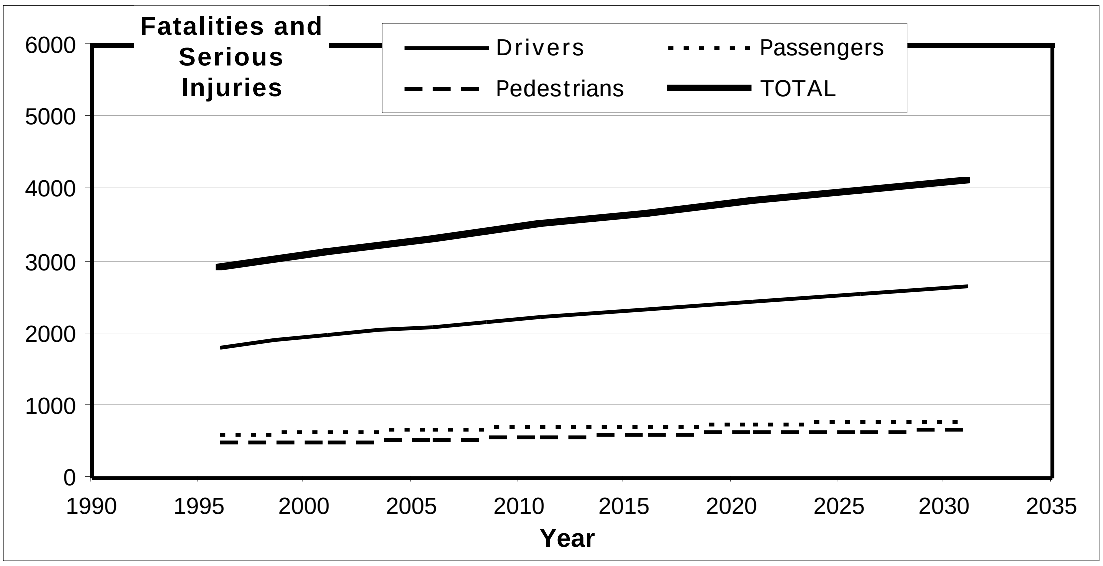

Figure 5 Projected Fatal and Serious Injuries to All People (>20 years old)

The number of male fatalities and serious injuries would rise by 32%, while the number of female fatalities and serious injuries would rise by 53%. The reasons for this increase are manifold.

- First, there will be an increase in State population.
- Second, more of this population will be elderly.
- Third, more of the elderly will be licenced.
- Fourth, licenced people travel greater distances, especially as car drivers.

This prediction of crash numbers is based on the assumption, however, that the travel patterns (kilometres travelled) and crash rates (per kilometre travelled) will remain constant over time. These results therefore show only the pressures placed on crash numbers as a result of demographic changes in the population.

Step 10: Calculate crash rates of various severities per head of population for future years

To remove the effect of simple population growth, crash rates (per head of population) have been calculated, as shown in Table 14 and Figure 6.

Table 14 Future Estimates of Crash Rates per Head of Population (>20 years)

	1996	2001	2006	2011	2016	2021	2026	2031
Male Population (>20)	1162805	1234184	1302743	1368195	1427364	1476529	1517178	1548265
Male Crash Rates/1000 popn								
Total Crash Involvements	11.87	11.81	11.69	11.59	11.47	11.35	11.24	11.16
Total Fatalites	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10
Total Serious Injuries	1.19	1.18	1.18	1.17	1.16	1.16	1.16	1.17
Total Minor Injuries	3.34	3.32	3.29	3.27	3.24	3.22	3.20	3.18
Total No Injuries	7.32	7.28	7.20	7.12	7.04	6.94	6.84	6.77

	1996	2001	2006	2011	2016	2021	2026	2031
Female Population (>20)	1232867	1308721	1381907	1452293	1517161	1573008	1621792	1661981
Female Crash Rates/1000 popn								
Total Crash Involvements	9.27	9.45	9.53	9.58	9.59	9.61	9.62	9.65
Total Fatalites	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
Total Serious Injuries	1.17	1.21	1.23	1.25	1.27	1.29	1.32	1.34
Total Minor Injuries	4.26	4.34	4.37	4.39	4.39	4.40	4.40	4.40
Total No Injuries	3.70	3.77	3.79	3.79	3.78	3.77	3.75	3.75

	1996	2001	2006	2011	2016	2021	2026	2031
Population (>20)	2395672	2542904	2684650	2820487	2944525	3049537	3138971	3210245
Crash Rates/1000 popn								
Total Crash Involvements	10.26	10.32	10.30	10.27	10.21	10.15	10.08	10.04
Total Fatalites	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07
Total Serious Injuries	1.15	1.16	1.17	1.18	1.18	1.19	1.20	1.21
Total Minor Injuries	3.69	3.72	3.72	3.71	3.70	3.69	3.67	3.66
Total No Injuries	5.35	5.36	5.33	5.30	5.24	5.18	5.12	5.07

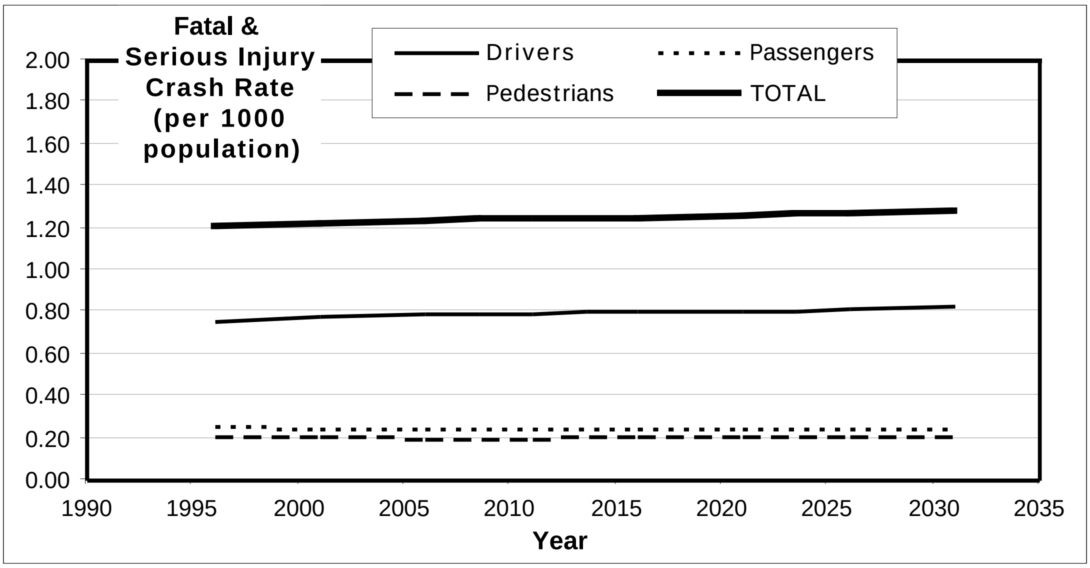

Figure 6 Fatal and Serious Injury Crash Rates per 1000 Population (>20 years)

It can be seen that car passenger and pedestrian fatal and serious injury crash rates per head of population will remain essentially constant over the next 30 years. Thus the growth in the number of car passenger and pedestrian fatal and serious injury crashes shown in Figure 5 is due primarily to population growth. The car driver crash rate per head of population, however, shows a 10% increase over the period 1996-2031, reflecting the underlying demographic structure changes occurring over that period.

The effects of these demographic structure changes can most visibly be seen by reference to Figure 7, which shows the projected growth in fatal and serious injury crashes over the period 1996-2031 for males and females of different ages.

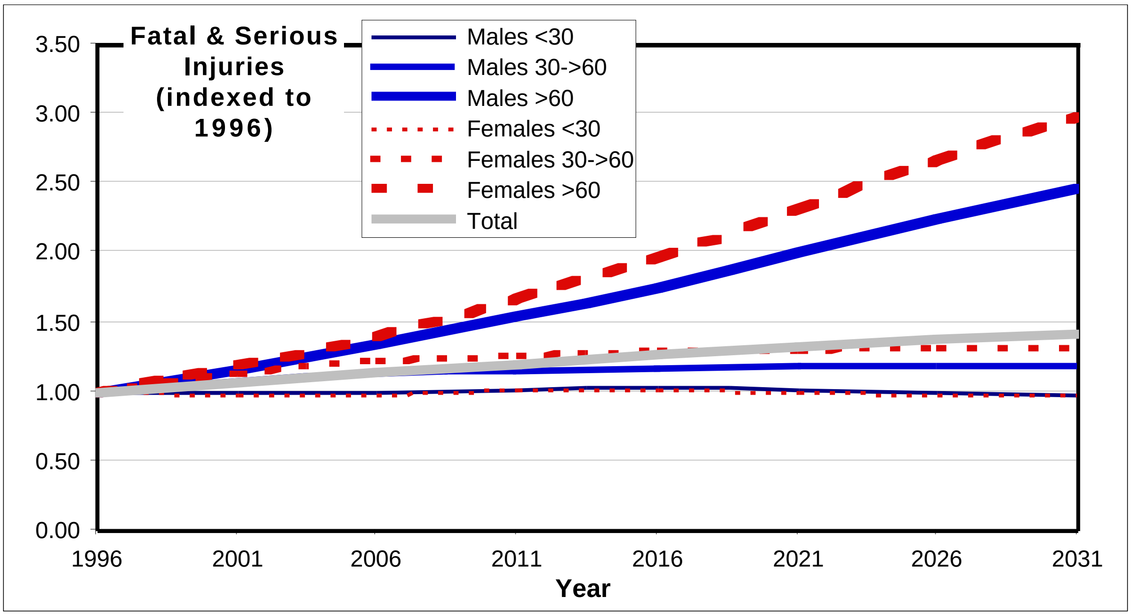

Figure 7 Changes in Fatalities and Serious Injuries by Age and Sex

It can be seen that the total number of fatal and serious injury crashes would increase by about 40% over the period 1996-2031. The number of fatal and serious injury crashes for young males and females (less than 30 years of age) remains essentially constant over the this period. This reflects the fact that there will be no growth in this demographic group, their licence holding will remain constant, as will their travel patterns. Middle-aged (30 to 60) males and females will show a 25% increase in the number of fatal and serious injury crashes, reflecting a slight increase in population and a growth in licence holding, particularly for females. The real growth area in the number of fatal and serious injury crashes is for people over 60. It can be seen that males over 60 will experience a 150% increase in fatal and serious injury crashes, while females over 60 will experience a 200% increase in fatal and serious injury crashes.

An alternative way of considering these changes is to look at the proportion of fatalities and serious injuries in the different demographic groups over time, as shown in Figure 8.

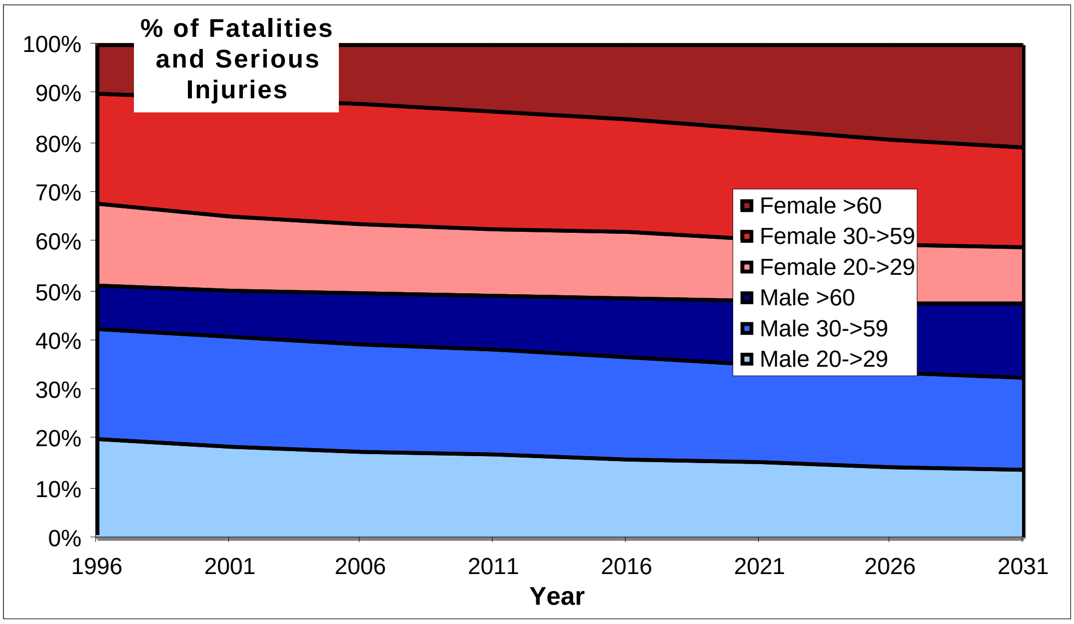

Figure 8 Shares of Fatalities and Serious Injuries by Age and Sex

Figure 8 shows that the proportion of fatalities and serious injuries occurring to males over 60 will rise from 9% in 1996 to 15% in 2031. Over the same period, the proportion of fatalities and serious injuries occurring to females over 60 will rise from 10% to 21%. Over this same period, the proportion of fatalities and serious injuries occurring to males under 30 will fall from 20% to 14%, while the proportion of fatalities and serious injuries occurring to females under 30 will fall from 17% to 11%.

Accounting for Changes in Crash Involvement Rates

The preceding analyses have assumed that the crash involvement rates will remain unaltered into the future. Because of this, the results shown above only show the changes in crash involvement due to demographic changes and do not account for changes in crash involvement rates within the demographic groups. However, the substantial fall in the road toll over the past 30 years, despite increases in population and driver licencing, is evidence that the crash involvement rate has been falling over that period. This reduction in crash involvement rate is expected to continue into the future. Vulcan and Corben (1998), for example, estimate that road fatalities will fall by over 50% over the period 1998-2010. They attribute this fall to the factors of improvements in vehicle safety features, road improvements, road user behaviour and emergency medical treatment, as shown in Table 15. Assuming that all these factors are independent of each other, they calculate a total reduction in the road toll of 57.4%. This is equivalent to a compound rate of reduction of 7% p.a. over that 12 year period.

Table 15 Estimated Reductions in Fatalities over the Period 1998-2010

Factor	Reduction
Vehicle safety features	20.2%
Road improvements	25.6%
Road user behaviour	22.0%
Emergency medical services	8%
Total reduction	57.4%

It is unlikely, however, that such a rate of reduction can be achieved across all severity levels because the various factors are not independent of each other, and because reductions in fatalities often lead to increases in non-fatal crash involvements. It is also apparent that the assumed rate of reduction is not necessarily occurring, with the 2000 Victorian road toll being 10% higher than the 1999 Victorian road toll. Therefore, a reduced rate of reduction in crash involvement has been used in the analysis to estimate the effect of possible changes in crash involvement rates in the future. In particular, the rate of reduction in crash involvement within each demographic group was varied in the search for a rate of reduction which would just compensate for the effects of the changes in demographic structure.

Under the assumption of a 1% p.a. reduction in crash involvement rates within all demographic groups, the effect on the number of fatal and serious injury crash involvements over the period 1996-2031 is shown in Figure 9. Assuming a 1% reduction in crash involvement rates within all demographic groups, the total number of fatal and serious injury crash involvements remains essentially constant over the period 1996-2031. The number of fatalities and serious injuries for young males and females (less than 30 years of age) decreases by about 30% over this period, while the number of fatalities and serious injuries for the middle-aged (30 to 60) males and females decreases by about 10%. However, males over 60 will still experience a 75% increase in fatal and serious injury crashes, while females over 60 will still experience a 110% increase in fatal and serious injury crashes.

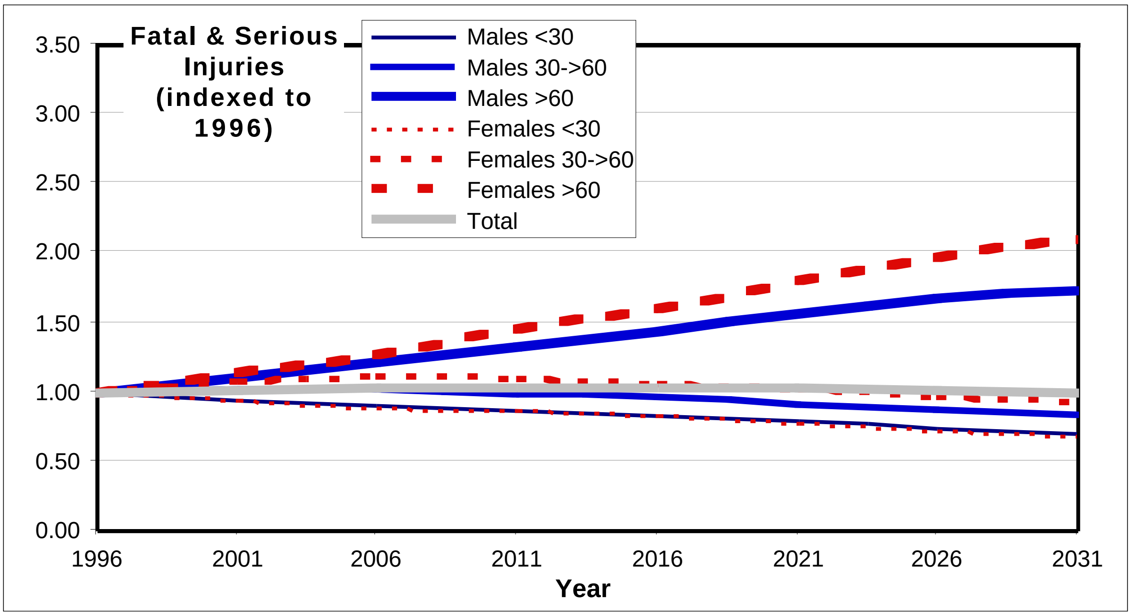

Figure 9 Changes in Fatalities and Serious Injuries by Age and Sex (after allowing for 3% p.a. reduction in crash involvement rates)

Overall, the 1% improvement in crash involvement rates (per kilometre travelled) have been totally counter-balanced by the increase in the number of old-aged people, and their increased use of the car as a result of increases in driver licencing in this age group over the period 1996-2031.

These relative changes in crash involvement will mean that the older person will be more of a road safety issue in future years. As a result of this, the focus of road safety programs will need to switch from the younger driver (as at present) to the older driver. Advertising campaigns and restrictions on access to vehicles (perhaps reverse P-plates as drivers exit from the driving population) will need to concentrate on the older driver, if the changes in trends of crash involvement brought about by demographic changes are to be anticipated and planned for in a pro-active manner.

Conclusions

While the Vision of a Zero Road Toll is laudable, this paper has challenged the Feasibility of a Zero Road Toll. Despite possible improvements in crash involvement rates within demographic groups, the paper has shown that known changes in demographic structure over the next 30 years will tend to counteract these reductions in crash involvement rates, especially for the older driver. If the rate of improvement in crash involvement rates slows below that expected by road safety experts, then demographic changes may well result in an increase in the road toll, rather than the expected decrease. Already such changes in direction in the road toll are starting to appear in several States.

The major point of this paper is that the changes predicted by the model described in this paper can be well anticipated. It is a known and irreversible fact that the population is ageing, and that the new generation of elderly will be more mobile than the old generations of the elderly. Unless serious attention is paid to the road safety problems and needs of the elderly, in the same way that the road safety problems of the young have been the focus of attention for many years, then we will see the explosion of road safety problems for the elderly predicted in this paper. While a Zero Road Toll is a nice Vision, the realities of demographic change compel us to direct our attention to dealing with a known future problem.

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